What is claimed is:

1. A method for making carbon fibers, the method including the steps of:

providing a precursor fiber;

providing a furnace configured to heat the fiber;

stabilizing the precursor fiber by heating the precursor fiber in an oxidizing environment in a heating chamber of the furnace while applying tension to the precursor fiber;

carbonizing the stabilized fiber by further heating the fiber in an oxidizing environment in the heating chamber of the furnace.

2. The method of claim 1 in which the steps of stabilizing and carbonizing each include:

continuously introducing ambient air into the furnace;

heating the air; and

blowing the heated air over the fiber in the heating chamber of the furnace.

Sub A1

3. The method of claim 1 in which the step of stabilizing includes:

initially heating the precursor fiber until reaching a heating chamber temperature of between approximately 174 and 185 degrees Celsius;

holding the heating chamber at this temperature for approximately 5 minutes until the material begins to stabilize;

after the precursor material begins to stabilize, raising the heating chamber temperature approximately 1.7-2.8 degrees Celsius per minute to approximately 204 degrees Celsius by increasing the temperature of the heated air being blown into the heating chamber; and

gradually raising the heating chamber temperature to approximately 227 to 232 degrees Celsius by increasing the temperature of the heated air being blown into the heating chamber at a rate sufficient for stabilization but insufficient for carbonization; and

the step of carbonizing includes:

quickly raising the heating chamber temperature to approximately 399 degrees Celsius by increasing the temperature of the air being introduced into the heating chamber at a rate that will carbonize the fiber.

4. The method of claim 1 in which the step of carbonizing includes carbonizing the fibers such that each resulting fiber is a biregional fiber that includes an inner non-carbonized core and an exterior carbonized sheath.

5. The method of claim 4 in which the step of providing precursor fibers includes providing a homogeneous polymeric material;

the step of stabilizing includes oxygen stabilizing an outer fiber portion of the polymeric material; and

the step of carbonizing includes forming a carbonized outer region and a non-carbonized inner region of each fiber.

6. The method of claim 5 in which the step of providing a homogeneous polymeric material includes providing a standard acrylic polymer.

7. The method of claim 1 in which the step of providing a precursor fiber includes providing a polyacrylonitrile (PAN) fiber.

8. A method for making carbon fibers, the method including the steps of:

providing a precursor fiber;

providing a furnace configured to heat the fiber;

stabilizing and carbonizing the fiber in a single continuous process that includes drawing the fiber continuously through the furnace.

Sub a2

9. A method for making carbon fibers, the method including the steps of:

providing an elongated precursor fiber;

providing a plurality of furnaces disposed adjacent one another in a serial side-by-side relationship and configured to heat the fiber to different respective temperatures as the fiber is drawn through the furnaces;

stabilizing the precursor fiber by heating the precursor fiber in an oxidizing environment as it is drawn through respective heating chambers of an initial group of the plurality of furnaces while applying tension to the precursor fiber; and

continuously carbonizing the stabilized fiber by further heating the fiber in an oxidizing environment as it is drawn through the heating chamber of a final one of the plurality of furnaces.

10. The method of claim 9 in which the step of stabilizing the precursor fiber includes:

heating the heating chamber of a first one of the plurality of furnaces to a first temperature;

heating the heating chamber of each subsequent furnace to a temperature higher than each respective preceding furnace;

heating the heating chamber of one of the furnaces to a temperature just below the flash point of the precursor fiber being stabilized; and

drawing the fiber through the heating chambers of the furnaces starting with the heating chamber of the first furnace.

Sub B3

11. The method of claim 10 in which the step of providing a plurality of furnaces includes configuring the furnaces such that the fiber is exposed to a temperature just below the flash point of the fiber for a longer period of time than the fiber spends at the other temperatures.

B3

12. The method of claim 11 in which the step of providing a plurality of furnaces includes:

providing an additional furnace adjacent the furnace that is heated to a temperature just below the flash point of the precursor fiber being stabilized;

heating the additional furnace to a temperature just below the flash point of the precursor fiber being stabilized; and

drawing the fiber through the furnaces such that the fiber passes through the heating chamber of the additional furnace after leaving the heating chamber of the furnace that is heated to just below the flash point of the fiber.

13. The method of claim 9 in which the step of carbonizing the fiber includes:

heating the heating chamber of a final one of the furnaces to a temperature that will carbonize at least a portion of the fiber; and

drawing the fiber through the heating chamber of the final furnace.

14. The method of claim 9 in which the step of providing a plurality of furnaces includes providing seven furnaces connected in series;

the step of stabilizing the precursor fiber includes:

heating the heating chamber of the first furnace to approximately 185 degrees Celsius;

heating the heating chamber of the second furnace to approximately 193 degrees Celsius;

heating the heating chamber of the third furnace to approximately 204 degrees Celsius;

heating the heating chamber of the fourth furnace to approximately 216 degrees Celsius;

heating the heating chambers of the fifth and sixth furnaces to approximately 232 degrees Celsius; and

drawing the fiber through the heating chambers of the first, second, third, fourth, fifth, sixth, and seventh furnaces in sequence.

15. The method of claim 14 in which the step of carbonizing the fiber includes:

heating the heating chamber of the seventh furnace to approximately 260 degrees Celsius; and

drawing the fiber through the heating chamber of the seventh furnace.

16. The method of claim 14 including the additional step of drawing the fiber through the furnace heating chambers at a rate that provides a residence time in each furnace of approximately 0.6 minutes.

17. The method of claim 15 including the additional step of introducing ambient air into each furnace.

18. The method of claim 17 including the additional step of adjusting downward the amount of ambient air introduced into furnaces that are operating at and above approximately 232 degrees Celsius.

19. The method of claim 18 including the additional step of restricting the airflow in furnaces operating at and above 232 degrees Celsius to approximately 60 percent (by volume) of the airflow in the furnaces operating below 232 degrees Celsius.

20. The method of claim 9 including the additional step of further graphitizing the fiber by adding additional furnaces operating at higher temperatures.

21. The method of claim 9 including the additional step of adjusting fiber draw rate to optimize the stabilization and carbonization processes.

22. The method of claim 9 in which:

the step of providing a plurality of furnaces includes spacing apart at least two adjacent ones of the furnaces; and

including the additional step of exposing the fiber to ambient air between the spaced-apart furnaces.

23. The method of claim 9 in which:

the step of providing a plurality of furnaces includes spacing apart at least two adjacent ones of the furnaces; and

including the additional step of enclosing the fiber as it passes between adjacent ones of the furnaces.

24. The method of claim 9 including the additional step of controlling the degree of carbonization of the fiber by adjusting the residence time within the furnaces.

25. The method of claim 9 including the additional step of forming a biregional fiber having an outer carbonized region and an inner virgin material region by carbonizing only an outer portion of the fiber.

26. The method of claim 25 in which the step of providing a precursor fiber includes providing a bipolymeric fiber containing an inner core of one polymer and an outer sheath of a second polymer that can be carbonized.

27. The method of claim 9 in which the step of providing a precursor fiber includes providing a polyacrylonitrile (PAN) type fiber.

restrict

28. An apparatus for forming carbon fibers that includes:

a first furnace having a heater;

an air supply system configured to direct a gas comprising oxygen over the heater and into a heating chamber;

a fiber guide configured to direct a fiber through the heating chamber; and

a dispersion plate disposed between the heater and the heating chamber and configured to evenly disperse heated air into the heating chamber and around the fiber.

29. The apparatus of claim 28 further including a plurality of fiber guides configured to simultaneously direct a corresponding plurality of fibers through the heating chamber and in which the dispersion plate is configured to evenly disperse heated air over the plurality of fibers.

30. An apparatus for forming carbon fibers that includes:

a first furnace having a heater and an air supply system configured to direct a gas comprising oxygen over the heater and into a first heating chamber at a first temperature;

a second furnace disposed adjacent the first furnace and having a heater and an air supply system configured to direct a gas comprising oxygen over the heater and into a second heating chamber at a second temperature; and

a fiber guide configured to direct a fiber through the first and second heating chambers.

31. The apparatus of claim 30 in which each furnace includes a dispersion plate disposed between the heater and heating chamber of that furnace, the dispersion plate being configured to evenly disperse heated air into the heating chamber of the furnace the dispersion plate is disposed in.

32. The apparatus of claim 30 including a plurality of furnaces disposed adjacent one another and configured to carbonize a precursor fiber in a continuous fashion.

33. The apparatus of claim 30 in which each furnace includes a heating element comprising an electrical rod heater.

34. The apparatus of claim 30 in which the air supply system is configured to introduce ambient air into the furnace.

35. The apparatus of claim 30 in which the dispersion plate is disposed above the heater.

36. The apparatus of claim 35 in which a second dispersion plate is disposed above the first dispersion plate.

37. The apparatus of claim 36 in which the second dispersion plate is spaced from the first dispersion plate by a distance that allows the airflow through the air passageways to become relatively evenly dispersed.

38. The apparatus of claim 30 in which the dispersion plate includes a plurality of symmetrically spaced air passageways configured to evenly disperse the flow of air entering the heating chamber.